FINAL REPORT

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PROJECT TITLE: Relative Nesting Success of Neotropical Woodland Migrants in Natural Riparian Woodlands and Farmstead Woodlots in Southeastern South Dakota.

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The stated objectives of this project as provided in the contract were to:

1. Determine abundance and species richness for birds breeding in natural riparian woodlands and farmstead woodlots in southeastern South Dakota.
2. Determine relative nesting success for Neotropical and short-distance migrants in riparian woodlands and farmstead woodlots. In addition, we will seek to locate and carefully monitor nests of any South Dakota Natural Heritage species that we may find in these habitats.
3. Undertake coarse-scale vegetative analyses around nest sites to identify vegetative characteristics potentially important to nest location and success in Neotropical short-distance migrants.

INTRODUCTION

Recent population declines have been documented for many species of Neotropical migrant birds breeding in North America (Robbins et al. 1989, Askins et al. 1990, DeGraaf and Rappole 1995), including several species breeding in South Dakota (Peterson 1995). These declines have been attributed to a number of factors that relate to conditions on breeding grounds (forest fragmentation and associated increases in nest predation and cowbird parasitism), wintering grounds (tropical deforestation), and along migratory routes (reductions in available stopover habitat) (Robbins et al. 1989, Terborgh 1989, Finch 1991, Moore et al. 1993). Forest fragmentation on the breeding grounds is one factor that has been implicated in population declines of Neotropical migrants, and avian density, species richness, and nesting success are generally reduced in forest fragments relative to larger sections of forest in eastern North America (Robbins et al. 1989, Askins et al. 1990). Reduced breeding success in fragmented parcels may be due to higher nest predation rates, as nest predation is higher at forest edges than in the interior (Wilcove 1985, Yahner and Scott 1988, Martin 1992), or to increased cowbird parasitism of nests, which is also more common at forest edges than in the interior (Brittingham and Temple 1983, Temple and Cary 1988, Robinson 1992, Robinson et al. 1995).

The foregoing comments apply principally to fragmented eastern deciduous forests, so whether these findings also apply to wooded habitats in the northern Great Plains is uncertain. Historically, woodland habitats within the northern Great Plains have been located almost exclusively along river corridors as riparian gallery forests (Van Bruggen 1996). These riparian woodlands provide breeding habitat for a number of species typical of eastern deciduous forests (SDOU 1991). However, because of their linear nature and their limited extent, within the grassland/agricultural field-dominated northern Great Plains, these habitats have considerably more edge than unfragmented eastern deciduous forest. In addition, these riparian habitats have been considerably reduced and altered over the past century by conversion to agricultural fields and flooding under Missouri River reservoirs (Hesse 1996). For example, Hesse et al. (1988) found that riparian habitats along the middle Missouri River were reduced by 40-80% from 1892-1982. However, additional woodland habitats have appeared in the northern Great Plains over the past century in the form of farmstead woodlots and shelterbelts, where previously only grasslands existed. These woodland habitats now account for a substantial fraction of the available woodland habitat in southeastern South Dakota (Castonguay 1982). Farmstead woodlots and shelterbelts occur as islands of woodland habitat in a landscape dominated by agricultural fields and pastures in this area (Martin 1980). Avian density and species richness generally increase with area within woodlots for breeding and migratory birds (Martin 1980, Yahner 1983, Bakker 2000). Bakker (2000) also found that natural woodlands in eastern South Dakota exhibited greater species richness of woodland obligate birds, but that planted woodlands attracted more woodland edge species. Whether breeding bird density and richness are lower in woodlots than in riparian corridor woodlands, which are generally of larger area even though they have been considerably fragmented, is unknown as no studies have directly addressed this question. During migration, avian density and richness were similar between riparian corridors and woodlots in southeastern South Dakota for Neotropical woodland migrants (Carlisle 1998, Dean 1999).

Relative nesting success within riparian forests and woodlots in the northern Great Plains is also unstudied. Farmstead woodlots and shelterbelts potentially could substitute for lost or degraded riparian woodlands by providing nesting habitat for Neotropical migrants, but only if productivity in anthropogenic habitats is similar to that for riparian woodlands (Dobkin 1994). Some authors have suggested that farmstead woodlots or fragmented forest parcels might serve as ecological traps by attracting birds to forested habitat while offering only limited nesting success (Gates and Gysel 1978, Robinson 1992, Dobkin 1994). Studies of relative nesting success in woodlots and riparian habitats in the northern Great Plains are needed to determine if anthropogenic woodland habitats can substitute for reduced natural woodland habitats as productive nesting habitat for Neotropical migrants. Such information is necessary for source-sink analyses of populations and would be useful for management decisions regarding forest preservation and Neotropical migrant conservation. The proposed study seeks to monitor abundance, species richness, and relative nesting success for Neotropical and short-distance migrant bird species nesting in both farmstead woodlots and riparian corridors in southeastern South Dakota to determine if these habitats serve as important breeding habitats for these species.

METHODS

Study Sites

Riparian study sites for this study included four sites in the Missouri River corridor in Clay and Union Counties and four sites in the Big Sioux River (and Brule Creek) corridor in Union and Lincoln Counties. The Missouri River study sites were located in riparian habitats west, south, and southeast of Vermillion. These include Clay County Park (42°45'N, 97°W), Myron Grove River Access Area (42°46'N, 97°07'W), a Game Production Area south of the Vermillion Airport (42°45'N, 96°58'W) and a River Access Area southeast of Burbank (42°42'N, 96°48'W). The Big Sioux River study sites included three sites in riparian woodlands along the Big Sioux River. These sites are River Sioux Park, where Highway 50 crosses the river from Union County into Iowa (42°45'N, 96°37'W), Wilson Savanna Preserve, Lincoln County (43°09'N, 96°30'W) and Oak Ridge GPA, Lincoln Co. (43°10'N, 96°30'W). In addition, one site (Union County State Park) was included with both riparian and upland woodlands along Brule Creek (42° 55′ N, 96° 46′ W), a tributary of the Big Sioux River. Riparian habitats along the Missouri River consisted of deciduous forest dominated by cottonwood (*Populus deltoides*), boxelder (*Acer negundo*), American elm (*Ulmus americana*), mulberry (*Morus alba*), and dogwood (*Cornus* spp.), except for the Burbank site, which also contained some early successional habitat dominated by willows (*Salix* spp.) and dogwood. The Big Sioux River sites were dominated by boxelder, silver maple (*Acer saccharinum*), American elm, bur oak (*Quercus macrocarpa*), and cottonwood. The riparian forest at Union County State Park consisted mainly of boxelder and American elm, while the upland forest was dominated by bur oak, with American elm and hackberry (*Celtis occidentalis*) also present. The Missouri River study sites have a generally west-east orientation, while the Big Sioux River and Brule Creek sites are oriented north to south.

We obtained permission to use thirteen different farmstead woodlots (15 survey points total) in Clay County as study sites. These included the same six woodlots as those studied by Swanson et al. (in prep.) for stopover biology of Neotropical woodland migrants, plus seven additional woodlots. These woodlots were scattered along an approximately 20-mile route and ranged from about 0.7-3.5 hectares in area. The architecture of the study woodlots was generally not linear and narrow (i.e., shelterbelts), but instead was roughly rectangular or arranged in an "L-shape." All woodlots were separated from each other by at least 1 km. The most common tree species in the six woodlots studied by Swanson et al. (in prep.) were elms, which comprised 54% of all trees counted. Other prominent woodlot tree species in that study included Mulberry (19.7%), Box Elder (8.7%), Hackberry (7.9%), and Green Ash (4.1%). A number of other tree species were also present, but they comprised less than 2% of the total.

Breeding Bird Abundance and Richness

For abundance and richness determination we used fixed-radius (25 m) point counts (Hutto et al. 1986). Roughly linear transects, 800-1000 m in length, were established at riparian study sites. Points were arranged along these transects and separated by at least 200 m to avoid double counting of birds. This provided 5-6 survey points at each riparian study site. At the Union County State Park site, two transects of three points each were established, one each in riparian and upland habitat types. Thus, Missouri and Big Sioux River (and tributary) corridors had 20-21 total survey points. Survey points were also established in the thirteen woodlots. Each woodlot had one point, except for the two largest (> 2.5 hectares), which had two points separated by more than 200 m. The 13 woodlots were divided into two transects, each with 7-8 points, for the point count surveys. Surveys were conducted four times during the breeding season and survey dates were 6-9 June, 27-30 June, 13-18 July, and 3-8 August. All counts were conducted between 0545 and 0930 CST and counts were not conducted on days with rain or high wind. Successive counts were separated by at least 10 days and the direction in which transects were conducted was reversed on successive counts to reduce possible temporal bias. This number of points and replicates has been shown to provide stable density estimates in habitats with heterogeneous vegetation (Morrison et al. 1981). All birds detected by sight or by sound were identified and counted and their distance from the point center was measured with a Ranging Model 620 rangefinder. Distances were recorded as inside or outside 25 m from the point center (Hutto et al. 1986, Bibby et al. 1992). Survey periods lasted 10 min per point. Birds detected while walking between points were counted and their distance from the nearest point recorded. Birds detected while flying overhead were counted only if they potentially used the habitat. Overall abundance was computed from detections inside 25 m to calculate densities (birds km^{-2}) and from all detections (inside and outside 25 m) to calculate relative abundances (birds/point) (Swanson 1999).

Nest Searching

Nest searches were conducted at six riparian study sites (Wilson Savanna and Oak Ridge GPA excluded) and at six different woodlots. Nest searching began in earnest on 21 May, although a few nests were actually monitored from early May, and continued through July. The last nesting effort that we monitored was finally complete on 5 September 2002. These dates cover the bulk of the nesting season for Neotropical migrants in South Dakota (SDOU 1991, Peterson 1995). Nests were checked every 3-4 d to monitor their activity and to determine success or failure. Nests were considered successful if they fledged at least one bird. If late nestlings were present on the previous nest check, but were absent on the final nest check, and evidence of fledging was present (e.g., excreta on the edge of the nest, fledglings in the immediate nest vicinity), the nest was considered successful and the fledgling date was considered as the midpoint between the two dates (Manolis et al. 2000). If evidence of fledging was absent, we used the previous date of observation to determine exposure days. Following fledging or nest failure, vegetation around the nest was described. Vegetation data included the plant species in which the nest was located, nest height, nest location (e.g., fork, on branch, cavity), distance to edge, and vegetation density and diversity. The size of vegetation sampling plots differed depending on the vegetative cover category. For open woodlands, we counted the number and species with stems > 1 cm in diameter at their base within a 10-m^2 radius circle centered on the nest tree, for dense woodlands, we used a 10-m^2 rectangle centered on the nest plant, and for dense shrubby habitat, we used two strip transects arranged perpendicular to each other, each 0.6 m wide and 10 m long and centered on the nest shrub.

Data Analysis

Daily nest survival rates for all species pooled, for Neotropical and short-distance migrants, for nest height categories (< 15 ft. vs. ≥ 15 ft.), and for individual species with sufficient nest numbers were calculated by the Mayfield method (Mayfield 1961, 1975). We used *Z*-tests (Johnson 1979) to statistically compare daily nest survival rates between natural and anthropogenic habitats and between other nesting categories. These tests were run for the overall Neotropical and short-distance migrant populations (all species pooled, categories based on DeGraaf and Rappole 1995), for general nest habitat categories (shrub vs. open woodland vs. dense woodland), and for individual species if they have sufficient observations or nests located ($n \geq 14$).

Overall avian abundance (i.e., numbers of observations) in corridors and woodlots was compared by Chi-square analysis after correction for equal effort. Comparisons of species richness among different sites and different studies are confounded by differences in sampling effort and numbers of observations because more species would be expected to be detected with an increased number of observations. The technique of rarefaction has been developed to compare richness at sites with different sample sizes and works by calculating an expected number of species ($E[S_n]$) for a given sample size from each site (James and Rathbun 1981). We calculated rarefaction curves for both riparian woodland and farmstead woodlot survey data and compared these curves with a Kolmogorov-Smirnov test (Zar 1996, Carlisle 1998, Dean 1999) to determine if species richness differed between the two habitats.

RESULTS AND DISCUSSION

Avian Abundance and Species Richness

Overall densities for all birds were 3,362 birds km^{-2} at Missouri River riparian sites, 2,565 birds km^{-2} at Big Sioux River (and tributaries) riparian sites, and 3,298 birds km^{-2} at woodlots. Overall relative abundances for all birds were 15.3 birds/point at Missouri River riparian sites, 13.8 birds/point at Big Sioux River (and tributaries) riparian sites, and 13.1 birds/point at woodlots. The overall numbers of birds observed on point counts was significantly higher at Missouri River sites than at Big Sioux River sites ($\chi^2 = 5.54$, $P = 0.02$) and at woodlot sites ($\chi^2 = 11.82$, $P < 0.001$). Overall numbers of observations did not differ significantly between Big Sioux River and woodlot study sites. The densities and relative abundances for individual species in corridors and woodlots are provided in Appendix 4. House Wrens (*Troglodytes aedon*) were the most abundant species in all habitat types, but their abundance in woodlots appeared to be higher than in corridors. Forest-edge species, such as American Robin (*Turdus migratorius*) and Common Grackle (*Quiscalus quiscula*) tended to have higher abundances in woodlots than in corridors in general, whereas forest interior species, such as Eastern Wood-Pewee (*Contopus virens*), Red-eyed Vireo (*Vireo olivaceous*), and Wood Thrush (*Hylocichla mustelina*) had higher abundances in corridors than in woodlots.

Overall species richness (number of species), excluding migratory species that do not breed in these habitats, was 44 at Missouri River riparian sites, 53 at Big Sioux River riparian sites and 37 at woodlots. Rarefaction curves for these habitats are provided in Figure 1. Rarefaction analyses indicated that species richness in the Big Sioux River corridor was significantly higher than at other study areas (Kolmogorov-Smirnov test, $D = 0.167$ for Big Sioux versus Missouri rivers, and $D = 0.250$ for Big Sioux versus woodlots, both $P < 0.001$). Species richness in the Missouri River corridor was significantly greater than that in woodlots ($D = 0.191$, $P < 0.001$). Finally, the percentages of these breeding species made up of Neotropical migrants (here defined as species in which most of the population winters south of the U.S. border) were 47.7% at Missouri River sites, 47.2% at Big Sioux River sites, and 40.5% at woodlots. These data suggest that abundances of birds were generally similar among sites, although Missouri River sites had the highest overall abundance, but that species richness and the percentage of species made up of Neotropical migrants was lower in woodlots than in riparian areas.

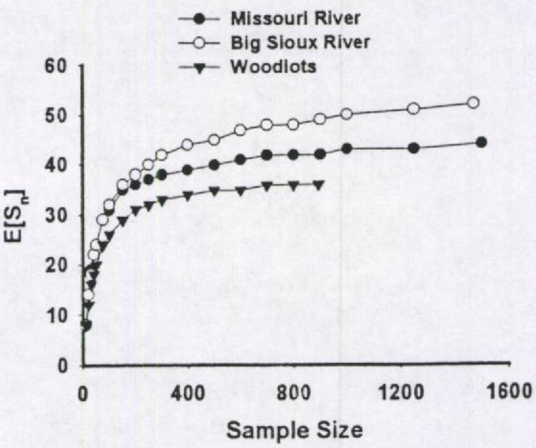

Figure 1. Expected species richness (E[Sn]) from rarefaction analyses for Missouri and Big Sioux river corridors and woodlots.

Avian Nesting Success

We conducted a pilot study of nesting success in many of the same study sites in the summer of 2000, and include those data here to increase the sample size for individual-species Mayfield comparisons. We found and monitored a total of 44 nests in 2000 and 372 nests in 2001 at all study sites, including totals of 218 at riparian sites and 198 at woodlots. The breakdown of nests per species is provided in Table 1. Raw data for nests, including date found (in Julian dates), exposure days, nest height, and nest tree species are included for all habitats in Appendices 1-3. Not surprisingly, nests from a greater number of bird species were found in corridors than in woodlots. Nests of 17 species were found in the Missouri River corridor, 16 species in the Big Sioux River corridor (22 species for both corridors combined), and 13 species in woodlots. Nests of American Robins were numerically dominant in woodlots, making up 85 of the total of 198 nests found. Nests of Yellow Warbler (*Dendroica petechia*) and Gray Catbird (*Dumetella carolinensis*) were the most common in corridors.

Mayfield analyses of overall nest success (cumulative daily nest success) for all species pooled gave values of 38.4% success in woodlots and 37.4% in corridors. These values did not differ significantly. We found 14 or more nests in both corridors and woodlots for four species (Table 1), so we were able to compare nest survival between corridors and woodlots for these species. None of these four species showed significant differences in daily nest survival rates between corridors and woodlots. P-values for these comparisons were 0.33 for Eastern Kingbirds (*Tyrannus tyrannus*), 0.68 for Gray Catbirds, 0.27 for American Robins, and 0.79 for Baltimore Orioles (*Icterus galbula*). Overall nest survival rates for these species, for woodlots and corridors, respectively were: Eastern Kingbird (89.3% in woodlots, 72.4% in corridors), Gray Catbird (28.0% in woodlots, 33.6% in corridors), American Robin (31.1% in woodlots, 48.7% in corridors), and Baltimore Oriole (80.1% in woodlots, 75.8% in corridors).

Daily nest survival of nest located above 15 feet in height was significantly higher ($P < 0.025$) than nests below 15 feet. However, nesting success of nests in the two height categories did not differ between corridors and woodlots. Distance from the nest to the edge of the woodland or shrub habitat had no significant influence on daily nest survival, as nest survival rates in 0-5 m, 5.1-20 m, and > 20 m categories were statistically indistinguishable. For habitat categories, daily nest survival was higher in open ($Z = 2.50$, $P < 0.01$) and dense woodlands ($Z = 2.55$, $P < 0.01$) than in shrub habitats, but nest survival in open and dense woodlands did not vary significantly. Some of this difference may be due to differences in nest height, as shrub nests were generally lower than those in open or dense woodlands. Finally, daily nest survival for all species of Neotropical migrants pooled was greater than that for all species of short-distance migrants pooled ($Z = 2.97$, $P < 0.002$) and Neotropical migrants had higher daily nest survival rates in woodlots than in corridors ($Z = 1.99$, $P < 0.05$).

These data suggest, in general, that nesting success is similar in woodlots and riparian areas. Moreover, although additional nests for several species are required before appropriate comparisons of nest success in corridors and woodlots can be made, most species appear to be as successful in woodlots as they are in corridors. Moreover, Neotropical migrants were actually more successful in woodlots than in riparian corridor woodlands, even though fewer Neotropical migrant species occurred in woodlots than in riparian corridor woodlands.

CONCLUSIONS

Avian abundance was generally similar between corridors and woodlots, but species richness was lower in woodlots than in corridors, particularly lower than in the Big Sioux River corridor, which showed the highest species richness of all study areas. Not surprisingly, much of the reduced richness in woodlots was due to the absence of species associated with woodland interiors or requiring larger woodland tracts for nesting. These species included Great Crested Flycatcher (*Myiarchus crinitus*), Yellow-throated (*Vireo flavifrons*) and Red-eyed (*V. olivaceous*) vireos, American Redstart (*Setophaga ruticilla*), Scarlet Tanager (*Piranga olivacea*), and Eastern Towhee (*Pipilo erythropthalamus*). Other species with similar habitat or nesting requirements that had much higher abundances in corridors than in woodlots were Eastern Wood-Pewee, Wood Thrush, and Rose-breasted Grosbeak (*Pheucticus ludovicianus*). The only species monitored by the South Dakota Natural Heritage program (Dowd Stukel and Backlund 1997) that was detected in woodlots was the Wood Thrush, and it occurred in woodlots only at very low densities (Appendix 4). South Dakota Natural Heritage species detected in corridors included Ruby-throated Hummingbird (*Archilochus colubris*), Yellow-throated Vireo, Blue-gray Gnatcatcher (*Polioptila caerulea*, Big Sioux River only), Wood Thrush, and Scarlet Tanager (Big Sioux River only).

In addition, Neotropical migrants comprised a greater proportion of the breeding species richness in river corridor woodlands (47% in both Missouri and Big Sioux river corridors) than in woodlots (40%). This percentage of Neotropical migrants is similar to avian communities documented for other natural woodland habitats in the northern Midwest or northern Great Plains, which range from 45-53% Neotropical migrants (Faanes 1984, Terborgh 1989, Liknes et al. 1994). These data suggest that river corridor woodlands and woodlots support similar overall avian abundances, but that the breeding bird community in woodlots has fewer species than that in corridors. This is particularly true for Neotropical migrant species. These data are consistent with those of other studies in the northern Midwest that documented a negative relationship between species richness or diversity and woodland area (Martin 1980, Yahner 1983, Bakker 2000).

Overall nesting success was similar between woodlots and corridors. Daily nest survival rates for general habitat categories (shrubs, open woodland, closed canopy woodland), nest height categories, distance to edge of vegetation, and individual species were also similar between woodlots and corridors. For Neotropical migrants, daily nest survival rates were actually slightly, but significantly, higher in woodlots than in riparian corridors. The general similarity in nesting success between corridors and woodlots and the better performance of Neotropical migrants in woodlots than in corridors was contrary to our initial expectations, which were that the larger areas and more contiguous nature of the river corridor woodlands would reduce predation and parasitism rates and elevate nesting success relative to woodlots. Perhaps this departure from our initial expectation is due to the still relatively small woodland area of riparian corridors (compared to Eastern deciduous forests) and the often narrow and linear nature of these corridor woodlands. These data suggest that woodlots provide acceptable nesting habitat for a variety of species, including many Neotropical migrants, despite the overall species richness being lower than in natural riparian woodlands. Thus, woodlots appear to substitute as nesting habitat, at least partially, for the markedly reduced extent of natural riparian corridor woodlands in this area.

Management Implications

The data in this study indicate that woodlots can provide adequate nesting habitat for a variety of avian species. Species showing regional or range-wide population declines that nested in woodlots were Brown Thrasher (*Toxostoma rufum*), Common Yellowthroat (*Geothlypis trichas*), Baltimore and Orchard (*Icterus spurius*) orioles, Rose-breasted Grosbeak, and Indigo Bunting (*Passerina cyanea*) (DeGraaf and Rappole 1995, Peterson 1995). Even the small woodlots in this study (0.7-3.5 hectares) appear to provide adequate nesting habitat for these and other species, so conservation of these habitats should benefit a number of birds. However, as Bakker (2000) noted, when grasslands were associated with nearby woodlands or shelterbelts, wooded habitats had a negative impact on the occurrence of grassland nesting birds. Thus, when considering the best procedures for conserving avian habitats, careful attention must be paid to the general habitat structure of woodlands and surrounding areas and to which birds represent the foremost conservation priorities. In addition, preservation of large natural riparian and upland woodlands is also important, because these habitats attract a wider variety of woodland nesting species than woodlots, including a higher percentage of Neotropical migrants and South Dakota Natural Heritage species.

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Table 1. Numbers of nests found in corridors and woodlots for individual open-cup nesting species. These totals include nests found during a pilot study in the summer of 2000, as well as the 372 nests found in the summer of 2001.

Species	Corridor Nests	Woodlot Nests
Yellow-billed Cuckoo	--	2
Eastern Wood-Pewee	5	--
Eastern Phoebe	2	--
Eastern Kingbird	18	14
Bell's Vireo	7	--
Warbling Vireo	5	--
Red-eyed Vireo	1	--
Wood Thrush	6	--
American Robin	14	85
Gray Catbird	30	21
Brown Thrasher	23	7
Cedar Waxwing	3	6
Yellow Warbler	36	--
American Redstart	8	--
Common Yellowthroat	1	--
Eastern Towhee	2	--
Chipping Sparrow	2	9
Field Sparrow	3	--
Northern Cardinal	--	2
Rose-breasted Grosbeak	24	4
Blue Grosbeak	1	--
Indigo Bunting	1	--
Red-winged Blackbird	--	2
Common Grackle	2	17
Orchard Oriole	7	14
Baltimore Oriole	20	15
TOTALS	218	198

Appendix 1. Raw data for nests in woodlots located during the summer of 2001. Bird Species is the four-letter BBL code. The H category refers to the combined hatching and nestling periods for the species in question. The Expos category refers to total exposure days for the nest in question for the Mayfield calculations. The Height and Tree Sp. categories refer to the height of the nest and the tree species in which it was found.

SITE	SPECIES	H	EXPOS	RESULT	START DATE	NEST #	HEIGHT	TREE SP.
BEARD	AMRO	32	2	FAIL	142	01AMRO01	15	MULBERRY
BEARD	AMRO	32	17.5	FLEDGE	142	02AMRO01	20	ELM
BEARD	AMRO	32	9	FAIL	142	03AMRO01	10	JUNIPER
BEARD	AMRO	32	6.5	FAIL	142	04AMRO01	10	PINE
BEARD	AMRO	32	2	FAIL	142	05AMRO01	20	COTTONWOOD
BEARD	AMRO	32	5.5	FLEDGE	142	06AMRO01	1.5	APPLE
BEARD	AMRO	32	5.5	FAIL	142	07AMRO01	6	COTTONWOOD
BEARD	AMRO	32	9.5	FAIL	145	08AMRO01	32	HACKBERRY
BEARD	AMRO	32	2.5	FAIL	145	09AMRO01	7	PINE (white)
BEARD	AMRO	32	31	FLEDGE	145	10AMRO01	22	HACKBERRY
BEARD	AMRO	32	7.5	FAIL	152	11AMRO01	9	APPLE (crab)
BEARD	AMRO	32	30.5	FLEDGE	152	12AMRO01	12	MULBERRY
BEARD	AMRO	32	9.5	FAIL	156	13AMRO01	16	COTTONWOOD
BEARD	AMRO	32	20	FAIL	156	14AMRO01	12	HACKBERRY
BEARD	AMRO	32	1	FLEDGE	162	15AMRO01	15	ASH
BEARD	AMRO	32	30.5	FLEDGE	166	16AMRO01	45	COTTONWOOD
BEARD	AMRO	32	2	FLEDGE	170	17AMRO01	25	WILLOW
BEARD	AMRO	32	16	FLEDGE	170	18AMRO01	35	COTTONWOOD
BEARD	AMRO	32	16.5	FLEDGE	173	19AMRO01	40	HACKBERRY
BEARD	AMRO	32	6.5	FAIL	173	20AMRO01	50	HACKBERRY
BEARD	AMRO	32	1.5	FLEDGE	178	21AMRO01	16	LOCUST
BEARD	AMRO	32	9	FLEDGE	184	22AMRO01	12	PINE
BEARD	AMRO	32	12.5	FAIL	184	23AMRO01	9.5	ASH
BEARD	AMRO	32	2.5	FAIL	187	24AMRO01	15	HACKBERRY
BEARD	AMRO	32	6	FLEDGE	197	25AMRO01	15	PINE
BEARD	AMRO	32	30	FLEDGE	187	26AMRO01	7	APPLE
BEARD	AMRO	32	23	FLEDGE	191	27AMRO01	9	APPLE
BEARD	AMRO	32	6	FAIL	194	28AMRO01	40	HACKBERRY
BEARD	BAOR	30.5	34.5	FLEDGE	145	01BAOR01	40	COTTONWOOD
BEARD	BAOR	30.5	25	UNCERTAIN	156	02BAOR01	40	COTTONWOOD
BEARD	BRTH	28	2	FAIL	142	01BRTH01	6	HONEYSUCKLE
BEARD	BRTH	28	12.5	FAIL	142	02BRTH01	3	RUSSIAN OLIVE

BEARD	BRTH	28	7.5	FLEDGE	152	03BRTH01	5.5	LILAC
BEARD	BRTH	28	2.5	FAIL	162	04BRTH01	6	PLUM
BEARD	BRTH	28	4.5	FAIL	178	05BRTH01	4	RUSSIAN OLIVE
BEARD	CEDW	32.5	30.5	FLEDGE	168	01CEDW01	18	RUSSIAN OLIVE
BEARD	CEDW	32.5	6	FAIL	170	02CEDW01	12	ELM
BEARD	CEDW	32.5	16.5	FAIL	180	03CEDW01	40	PINE
BEARD	CEDW	32.5	2	FAIL	191	04CEDW01	22	HACKBERRY
BEARD	CEDW	32.5	17.5	FLEDGE	191	05CEDW01	30	ASH
BEARD	CEDW	32.5	5.5	FLEDGE	191	06CEDW01	40	PINE (white)
BEARD	CHSP	26.5	7.5	FLEDGE	152	01CHSP01	2	BORVITAE BUSH
BEARD	CHSP	26.5	7.5	FLEDGE	152	02CHSP01	12	PINE
BEARD	CHSP	26.5	6	FLEDGE	166	03CHSP01	3	SPRUCE
BEARD	CHSP	26.5	16.5	FAIL	166	04CHSP01	5.5	SPRUCE
BEARD	CHSP	26.5	13.5	FLEDGE	166	05CHSP01	25	PINE
BEARD	CHSP	26.5	10.5	FAIL	173	06CHSP01	40	HACKBERRY
BEARD	CHSP	26.5	23.5	FLEDGE	180	07CHSP01	5	PINE
BEARD	CHSP	26.5	16.5	FAIL	187	08CHSP01	9	PINE
BEARD	COGR	35.5	30	FLEDGE	142	01COGR01	12	PINE
BEARD	COGR	35.5	12.5	FLEDGE	142	02COGR01	11	PINE
BEARD	COGR	35.5	7	FAIL	142	03COGR01	7	PINE
BEARD	COGR	35.5	5.5	FAIL	142	04COGR01	15	PINE
BEARD	COGR	35.5	12.5	FLEDGE	142	05COGR01	8	PINE
BEARD	COGR	35.5	2.5	FAIL	145	06COGR01	9	SPRUCE
BEARD	COGR	35.5	2.5	FLEDGE	145	07COGR01	6	PINE
BEARD	COGR	35.5	2.5	FLEDGE	145	08COGR01	6	SPRUCE
BEARD	COGR	35.5	2.5	FAIL	145	09COGR01	10	PINE
BEARD	COGR	35.5	6	FLEDGE	145	10COGR01	15	PINE
BEARD	COGR	35.5	1	UNCERTAIN	152	11COGR01	15	PINE
BEARD	COGR	35.5	7.5	FLEDGE	152	12COGR01	26	PINE
BEARD	EAKI	37.5	37	FLEDGE	149	01EAKI01	15	ELM
BEARD	EAKI	37.5	27.5	FLEDGE	162	02EAKI01	20	MULBERRY
BEARD	EAKI	37.5	24.5	FLEDGE	166	03EAKI01	25	ELM
BEARD	EAKI	37.5	26.5	FLEDGE	170	04EAKI01	8	MULBERRY
BEARD	GRCA	27	9	FAIL	142	01GRCA01	3	LILAC
BEARD	GRCA	27	5.5	FAIL	142	02GRCA01	3	LILAC
BEARD	GRCA	27	12.5	FAIL	142	03GRCA01	7	LILAC
BEARD	GRCA	27	9	FAIL	142	04GRCA01	7	HONEYSUCKLE

BEARD	GRCA	27	12.5	FAIL	156	05GRCA01	10	HACKBERRY
BEARD	GRCA	27	30	FLEDGE	156	06GRCA01	6	PLUM
BEARD	GRCA	27	12.5	FAIL	156	07GRCA01	6	ERSWEET BUSH
BEARD	GRCA	27	20.5	FAIL	162	08GRCA01	4	FORSYTHIA
BEARD	GRCA	27	10	FAIL	166	09GRCA01	3	LILAC
BEARD	GRCA	27	2.5	FAIL	166	10GRCA01	7	LILAC
BEARD	GRCA	27	10	FAIL	166	11GRCA01	7	LILAC
BEARD	GRCA	27	6	FAIL	187	12GRCA01	2.5	LILAC
BEARD	GRCA	27	5.5	FAIL	191	13GRCA01	5	LILAC
BEARD	NOCA	25.5	2.5	FLEDGE	145	01NOCA01	2	JUNIPER
BEARD	NOCA	25.5	27.5	FLEDGE	179	02NOCA01	15	PINE (white)
BEARD	OROR	28.5	16	FAIL	156	01OROR01	12	MULBERRY
BEARD	OROR	28.5	24	FLEDGE	162	02OROR01	12	ELM
BEARD	RBGR	28	17.5	FAIL	162	01RBGR01	8	ELM
BEARD	YBCU	21.5	9.5	FAIL	170	01YBCU01	25	WILLOW
BEARD	YBCU	21.5	5.5	FAIL	191	02YBCU01	22	ASH
L-SHAPE	AMRO	32	27	UNCERTAIN	170	01AMRO01	27	ELM
L-SHAPE	RBGR	28	16.5	FAIL	156	01RBGR01	9	MULBERRY
L-SHAPE	RBGR	28	24	FLEDGE	180	02RBGR01	12	MULBERRY
NO HOUSE	EAKI	37.5	35	FLEDGE	180	01EAKI01	21	ELM
RENNER	AMRO	32	3.5	FAIL	156	01AMRO01	10	HACKBERRY
RENNER	AMRO	32	23	FLEDGE	156	02AMRO01	9	BOX ELDER
RENNER	AMRO	32	8.5	FAIL	156	03AMRO01	21	BOX ELDER
RENNER	AMRO	32	6.5	FAIL	166	04AMRO01	35	HACKBERRY
RENNER	AMRO	32	20	FLEDGE	166	05AMRO01	50	COTTONWOOD
RENNER	AMRO	32	23.5	FAIL	166	06AMRO01	4	MULBERRY
RENNER	AMRO	32	30.5	.FLEDGE	166	07AMRO01	7	ELM
RENNER	AMRO	32	23.5	FAIL	184	08AMRO01	20	BOX ELDER
RENNER	AMRO	32	2	FAIL	191	09AMRO01	15	ELM
RENNER	AMRO	32	5.5	FLEDGE	198	10AMRO01	5	ELM
RENNER	BAOR	30.5	6	FLEDGE	156	01BAOR01	6	ELM
RENNER	BAOR	30.5	6	FAIL	156	02BAOR01	40	COTTONWOOD
RENNER	BAOR	30.5	30.5	FLEDGE	173	03BAOR01	22	ELM
RENNER	GRCA	27	23	FLEDGE	170	01GRCA01	5	MULBERRY
SWANSON	AMRO	32	31	FLEDGE	120	01AMRO01	25	LOCUST
SWANSON	AMRO	32	27.5	FLEDGE	120	02AMRO01	15	ELM
SWANSON	AMRO	32	8	FAIL	120	03AMRO01	8	ELM

SWANSON	AMRO	32	28.5	FAIL	123	04AMRO01	22.5	HACKBERRY
SWANSON	AMRO	32	28.5	FLEDGE	123	05AMRO01	25	ELM
SWANSON	AMRO	32	6.5	FAIL	125	06AMRO01	6	ASH
SWANSON	AMRO	32	12.5	FAIL	126	07AMRO01	27	ELM
SWANSON	AMRO	32	4	FAIL	127	08AMRO01	12	ELM
SWANSON	AMRO	32	25.5	FLEDGE	130	09AMRO01	5	ELM
SWANSON	AMRO	32	29.5	FLEDGE	130	10AMRO01	20	ELM
SWANSON	AMRO	32	20.5	FLEDGE	135	11AMRO01	16.5	BOX ELDER
SWANSON	AMRO	32	14	FAIL	142	13AMRO01	18	
SWANSON	AMRO	32	13.5	FLEDGE	142	14AMRO01	5	ELM
SWANSON	AMRO	32	2.5	FAIL	149	15AMRO01	29	ELM
SWANSON	AMRO	32	14	FLEDGE	153	16AMRO01	15	ELM
SWANSON	AMRO	32	3.5	FLEDGE	154	17AMRO01	10	ELM
SWANSON	AMRO	32	23	FLEDGE	161	18AMRO01	30	COTTONWOOD
SWANSON	AMRO	32	6.5	FAIL	169	19AMRO01	15	BOX ELDER
SWANSON	AMRO	32	18.5	FAIL	170	20AMRO01	15	ELM
SWANSON	AMRO	32	1	UNCERTAIN	170	21AMRO01	40	COTTONWOOD
SWANSON	AMRO	32	14	FLEDGE	170	22AMRO01	13.5	MULBERRY
SWANSON	AMRO	32	2	FAIL	170	23AMRO01	27.5	MULBERRY
SWANSON	AMRO	32	7	FLEDGE	177	24AMRO01	35	OAK
SWANSON	AMRO	32	7.5	FAIL	181	25AMRO01	20	ELM
SWANSON	AMRO	32	19.5	FAIL	169	26AMRO01	15	ELM
SWANSON	AMRO	32	6.5	FAIL	186	27AMRO01	15	ELM
SWANSON	AMRO	32	29.5	FLEDGE	181	28AMRO01	40	MULBERRY
SWANSON	AMRO	32	12.5	FLEDGE	208	29AMRO01	15	APPLE
SWANSON	AMRO	32	7	FLEDGE	223	30AMRO01	13.5	ASH
SWANSON	BAOR	30.5	25.5	FAIL	145	01BAOR01	25	COTTONWOOD
SWANSON	BAOR	30.5	34.5	FLEDGE	145	02BAOR01	40	ELM
SWANSON	BAOR	30.5	35	FLEDGE	149	03BAOR01	15	ELM
SWANSON	BAOR	30.5	26.5	FLEDGE	149	04BAOR01	18	ELM
SWANSON	BAOR	30.5	14.5	FLEDGE	157	05BAOR01	30	COTTONWOOD
SWANSON	BAOR	30.5	15.5	FLEDGE	181	06BAOR01	30	COTTONWOOD
SWANSON	BRTH	28	9.5	FAIL	134	01BRTH01	3.5	ELM
SWANSON	COGR	35.5	8.5	FAIL	135	01COGR01	10	ELM
SWANSON	COGR	35.5	14	FLEDGE	145	02COGR01	40	PINE
SWANSON	COGR	35.5	22.5	FAIL	145	03COGR01	8	PLUM
SWANSON	COGR	35.5	9.5	FAIL	170	04COGR01	26	MULBERRY

SWANSON	COGR	35.5	18.5	FLEDGE	170	05COGR01	20	ELM
SWANSON	EAKI	37.5	49.5	FLEDGE	154	01EAKI01	40	ELM
SWANSON	EAKI	37.5	36.5	FLEDGE	156	02EAKI01	37.5	ELM
SWANSON	EAKI	37.5	15.5	FAIL	164	03EAKI01	30	MULBERRY
SWANSON	EAKI	37.5	11.5	FLEDGE	177	04EAKI01	30	MULBERRY
SWANSON	EAKI	37.5	11.5	FLEDGE	205	05EAKI01	37.5	MULBERRY
SWANSON	GRCA	27	4.5	FAIL	151	01GRCA01	4	FORSYTHIA
SWANSON	GRCA	27	28	FLEDGE	156	02GRCA01	2	ELM
SWANSON	GRCA	27	32.5	FLEDGE	156	03GRCA01	8	MULBERRY
SWANSON	GRCA	27	5.5	FLEDGE	166	04GRCA01	15	ELM
SWANSON	GRCA	27	15.5	FLEDGE	181	05GRCA01	18	ELM
SWANSON	OROR	28.5	35	FLEDGE	149	01OROR01	10	ELM
SWANSON	OROR	28.5	11.5	FAIL	156	02OROR01	12	ELM
SWANSON	OROR	28.5	14.5	FAIL	156	03OROR01	20	MULBERRY
SWANSON	OROR	28.5	39.5	FLEDGE	157	04OROR01	35	ELM
SWANSON	OROR	28.5	30.5	FLEDGE	166	05OROR01	20	MULBERRY
SWANSON	OROR	28.5	15.5	FLEDGE	181	06OROR01	40	ELM
SWANSON	OROR	28.5	2.5	FLEDGE	186	07OROR01	18	ELM
SWANSON	RBGR	28	7.5	FLEDGE	164	01RBGR01	16.5	ELM
SWANSON	RWBL	26.5	6	FAIL	157	01RWBL01	2	BOX ELDER
SWANSON	RWBL	26.5	2.5	FAIL	169	02RWBL01	3	BOX ELDER
BEARD	AMRO	32	3	FLEDGE	173	01AMRO00	6	ELM
BEARD	AMRO	32	7	FAIL	178	02AMRO00	8	ELM
BEARD	AMRO	32	2.5	FAIL	178	03AMRO00	6	PINE (scotch)
BEARD	AMRO	32	10.5	FLEDGE	191	04AMRO00	12	HACKBERRY
BEARD	BAOR	30.5	6	UNCERTAIN	173	01BAOR00	26	HACKBERRY
BEARD	BAOR	30.5	6	FLEDGE	187	02BAOR00	20	HACKBERRY
BEARD	CEDW	32.5	23.5	FLEDGE	178	01CEDW00	12	PLUM
BEARD	CHSP	26.5	2	FAIL	191	01CHSP00	5	PINE (austrian)
BEARD	EAKI	37.5	11.5	UNCERTAIN	178	01EAKI00	15	ELM
BEARD	EAKI	37.5	14.5	FLEDGE	187	02EAKI00	15	ELM
BEARD	OROR	28.5	3	FLEDGE	173	01OROR00	10	ELM
SWANSON	GRCA	27	7	FLEDGE	165	01GRCA00	5.5	ELM
SWANSON	GRCA	27	21	FLEDGE	184	03GRCA00	15	ELM
SWANSON	BAOR	30.5	7	UNCERTAIN	167	01BAOR00	40	ELM
SWANSON	BAOR	30.5	4	UNCERTAIN	168	02BAOR00	35	ELM
SWANSON	EAKI	37.5	20.5	FLEDGE	167	01EAKI00	35	MULBERRY

SWANSON	EAKI	37.5	9	UNCERTAIN	172	02EAKI00	50	ELM
SWANSON	AMRO	32	23	FAIL	143	01AMRO00	6	ELM
SWANSON	AMRO	32	3	UNCERTAIN	143	02AMRO00	5.5	MULBERRY
SWANSON	AMRO	32	20.5	FLEDGE	165	03AMRO00	7	ELM
SWANSON	AMRO	32	6	FAIL	168	04AMRO00	15	ELM
SWANSON	AMRO	32	21.5	FLEDGE	168	05AMRO00	20	ELM
SWANSON	AMRO	32	9.5	FAIL	170	06AMRO00	7	BOX ELDER
SWANSON	AMRO	32	5.5	FLEDGE	172	07AMRO00	12	ELM
SWANSON	AMRO	32	22	FLEDGE	172	08AMRO00	20	ELM
SWANSON	AMRO	32	20	FLEDGE	173	09AMRO00	20	MAPLE
SWANSON	AMRO	32	2.5	FAIL	152	10AMRO00	20	ELM
SWANSON	AMRO	32	17.5	FLEDGE	177	11AMRO00	10	HACKBERRY
SWANSON	AMRO	32	5	FLEDGE	187	12AMRO00	27	OAK
SWANSON	AMRO	32	18.5	FAIL	183	13AMRO00	9	APPLE
SWANSON	OROR	28.5	4	UNCERTAIN	172	02OROR00	18	ASH
SWANSON	OROR	28.5	9.5	FLEDGE	172	03OROR00	10	BOX ELDER
SWANSON	OROR	28.5	15.5	FLEDGE	177	04OROR00	20	ELM
SWANSON	BRTH	28	21.5	FLEDGE	172	01BRTH00	3.5	ELM
		31.13384	2776					

Appendix 2. Raw data for nests in the Missouri River corridor located during the study. Codes are the same as in Appendix 1.

SITE	SPECIES	H	EXPOS	RESULT	START DATE	NEST #	HEIGHT	TREE SP.
AIRPORT	AMRO	32	19.5	FLEDGE	171	01AMRO01	25	ELM
AIRPORT	AMRO	32	14.5	FLEDGE	188	02AMRO01	40	TTONWOOD
AIRPORT	AMRO	32	7	FAIL	188	03AMRO01	20	ELM
AIRPORT	BAOR	30.5	36	FLEDGE	144	01BAOR01	40	TTONWOOD
AIRPORT	BAOR	30.5	36	FLEDGE	144	02BAOR01	37.5	TTONWOOD
AIRPORT	BAOR	30.5	11	UNCERTAIN	157	03BAOR01	57.5	TTONWOOD
AIRPORT	BAOR	30.5	12	UNCERTAIN	164	04BAOR01	35	TTONWOOD
AIRPORT	BAOR	30.5	32.5	FLEDGE	171	05BAOR01	70	TTONWOOD
AIRPORT	BAOR	30.5	12	UNCERTAIN	181	06BAOR01	32.5	TTONWOOD
AIRPORT	BAOR	30.5	3	UNCERTAIN	183	07BAOR01	60	TTONWOOD
AIRPORT	BAOR	30.5	1	UNCERTAIN	183	08BAOR01	60	TTONWOOD
AIRPORT	BRTH	28	5.5	FAIL	144	01BRTH01	5	PLUM
AIRPORT	BRTH	28	19	FLEDGE	164	02BRTH01	4.5	VINE
AIRPORT	BRTH	28	16.5	FLEDGE	164	03BRTH01	8	ASH
AIRPORT	BRTH	28	2	FAIL	164	04BRTH01	6	PLUM
AIRPORT	BRTH	28	3	FAIL	192	05BRTH01	12	DOGWOOD
AIRPORT	COYE	26	10.5	FAIL	144	01COYE01	0	DOGWOOD
AIRPORT	EAKI	37.5	25	FLEDGE	183	01EAKI01	45	TTONWOOD
AIRPORT	GRCA	27	7.5	FAIL	162	01GRCA01	2	SHRUB
AIRPORT	GRCA	27	22.5	FAIL	164	02GRCA01	5	DOGWOOD
AIRPORT	GRCA	27	19.5	FLEDGE	171	03GRCA01	12	DOGWOOD
AIRPORT	GRCA	27	6.5	FAIL	171	04GRCA01	10	BUCKTHORN
AIRPORT	RBGR	28	22.5	FLEDGE	141	01RBGR01	15	ASH
AIRPORT	RBGR	28	25.5	FLEDGE	144	02RBGR01	16.5	ELM
AIRPORT	RBGR	28	11	FAIL	150	03RBGR01	8	ELM
AIRPORT	RBGR	28	4	FAIL	157	04RBGR01	6.5	BUCKEYE
AIRPORT	RBGR	28	4	FLEDGE	157	05RBGR01	6.5	BUCKTHORN
AIRPORT	RBGR	28	18	FLEDGE	162	06RBGR01	7	DOGWOOD
AIRPORT	RBGR	28	21	UNCERTAIN	164	07RBGR01	26	MULBERRY
AIRPORT	RBGR	28	1	UNCERTAIN	164	08RBGR01	25	WALNUT
AIRPORT	RBGR	28	31	FLEDGE	164	09RBGR01	35	ELM
AIRPORT	RBGR	28	15.5	FLEDGE	171	10RBGR01	13.5	DOGWOOD
AIRPORT	WOTH	29	16.5	FAIL	157	01WOTH01	5.5	DOGWOOD
AIRPORT	WOTH	29	5.5	FAIL	164	02WOTH01	5	DOGWOOD
AIRPORT	WOTH	29	15.5	FLEDGE	175	03WOTH01	8	DOGWOOD

AIRPORT	WOTH	29	3	FLEDGE	192	04WOTH01	10	DOGWOOD
BURBANK	AMRE	25	12.5	FAIL	155	01AMRE01	7	WILLOW
BURBANK	AMRE	25	23	FLEDGE	155	02AMRE01	14	DOGWOOD
BURBANK	AMRE	25	9	FAIL	155	03AMRE01	10	DOGWOOD
BURBANK	AMRE	25	2.5	FLEDGE	165	04AMRE01	12	DOGWOOD
BURBANK	AMRE	25	5.5	FLEDGE	176	05AMRE01	8	BOXELDER
BURBANK	BAOR	30.5	16	FLEDGE	162	01BAOR01	25	TTONWOOD
BURBANK	BAOR	30.5	9.5	FLEDGE	165	03BAOR01	27.5	TTONWOOD
BURBANK	BAOR	30.5	12.5	FLEDGE	165	04BAOR01	40	TTONWOOD
BURBANK	BAOR	30.5	22.5	FAIL	169	05BAOR01	25	TTONWOOD
BURBANK	BAOR	30.5	8.5	FLEDGE	169	06BAOR01	35	TTONWOOD
BURBANK	BAOR	30.5	5.5	FLEDGE	169	07BAOR01	50	TTONWOOD
BURBANK	BEVI	29.5	2	FAIL	155	01BEVI01	2.5	DOGWOOD
BURBANK	BEVI	29.5	24.5	FLEDGE	158	02BEVI01	2.5	DOGWOOD
BURBANK	BEVI	29.5	26.5	FLEDGE	162	03BEVI01	3	DOGWOOD
BURBANK	BEVI	29.5	1	FAIL	165	04BEVI01	2.5	DOGWOOD
BURBANK	BEVI	29.5	16.5	FAIL	169	05BEVI01	2	DOGWOOD
BURBANK	BEVI	29.5	24	FLEDGE	189	06BEVI01	4	DOGWOOD
BURBANK	BEVI	29.5	8.5	FAIL	204	07BEVI01	3	DOGWOOD
BURBANK	BRTH	28	12.5	FAIL	148	01BRTH01	10	SUMAC
BURBANK	BRTH	28	16	FAIL	162	02BRTH01	4.5	VINE
BURBANK	CEDW	32.5	2.5	FAIL	165	01CEDW01	7	SSIAN OLIVE
BURBANK	EAKI	37.5	19	FAIL	152	01EAKI01	5	WILLOW
BURBANK	EAKI	37.5	40	FLEDGE	155	02EAKI01		COTTONWOOD
BURBANK	EAKI	37.5	38	FLEDGE	158	03EAKI01	3	SSIAN OLIVE
BURBANK	EAKI	37.5	30	FLEDGE	165	06EAKI01	60	TTONWOOD
BURBANK	EAKI	37.5	9	FAIL	169	07EAKI01	5	DOGWOOD
BURBANK	EAKI	37.5	37.5	FLEDGE	172	08EAKI01	6	TTONWOOD
BURBANK	EAKI	37.5	2	FLEDGE	193	10EAKI01	40	TTONWOOD
BURBANK	EAWP	31	33.5	FLEDGE	165	01EAWP01	30	TTONWOOD
BURBANK	EAWP	31	23.5	FAIL	162	02EAWP01	37.5	TTONWOOD
BURBANK	EAWP	31	2	FLEDGE	193	03EAWP01	50	TTONWOOD
BURBANK	GRCA	27	12	FAIL	145	01GRCA01	6	DOGWOOD
BURBANK	GRCA	27	23	FLEDGE	148	02GRCA01	10	VINE
BURBANK	GRCA	27	23	FLEDGE	148	03GRCA01	10	SHRUB
BURBANK	GRCA	27	22	FLEDGE	148	04GRCA01	2	BUSH
BURBANK	GRCA	27	19.5	FLEDGE	155	06GRCA01	5.5	DOGWOOD

BURBANK	GRCA	27	6	FLEDGE	165	07GRCA01	6	DOGWOOD
BURBANK	GRCA	27	22.5	FAIL	176	09GRCA01	9.5	DOGWOOD
BURBANK	OROR	28.5	26.5	FLEDGE	155	01OROR01	45	TTONWOOD
BURBANK	OROR	28.5	4	UNCERTAIN	169	02OROR01	12.5	SSIAN OLIVE
BURBANK	OROR	28.5	23	FAIL	172	03OROR01	50	TTONWOOD
BURBANK	OROR	28.5	9.5	FAIL	172	04OROR01	30	TTONWOOD
BURBANK	RBGR	28	19	FLEDGE	145	01RBGR01	11	SUMAC
BURBANK	WAVI	32	12.5	FAIL	162	01WAVI01	27.5	TTONWOOD
BURBANK	WAVI	32	24.5	FAIL	162	02WAVI01	32.5	TTONWOOD
BURBANK	YWAR	26.5	13	FAIL	144	01YWAR01	5	DOGWOOD
BURBANK	YWAR	26.5	26.5	FLEDGE	148	02YWAR01	5	DOGWOOD
BURBANK	YWAR	26.5	9	FAIL	148	03YWAR01	12	BOXELDER
BURBANK	YWAR	26.5	15.5	FAIL	144	04YWAR01	10	DOGWOOD
BURBANK	YWAR	26.5	23	FLEDGE	148	05YWAR01	10	DOGWOOD
BURBANK	YWAR	26.5	16	FAIL	148	06YWAR01	3	DOGWOOD
BURBANK	YWAR	26.5	9	FAIL	148	07YWAR01	10	DOGWOOD
BURBANK	YWAR	26.5	26.5	FLEDGE	155	08YWAR01	12	DOGWOOD
BURBANK	YWAR	26.5	9	FAIL	155	09YWAR01	12	DOGWOOD
BURBANK	YWAR	26.5	12.5	FAIL	155	10YWAR01	4	DOGWOOD
BURBANK	YWAR	26.5	6	FLEDGE	158	12YWAR01	9	DOGWOOD
BURBANK	YWAR	26.5	20	FLEDGE	158	12YWAR01	12	SUMAC
BURBANK	YWAR	26.5	9	FAIL	162	14YWAR01	2.5	DOGWOOD
BURBANK	YWAR	26.5	2.5	FAIL	165	16YWAR01	6	DOGWOOD
BURBANK	YWAR	26.5	11	FAIL	165	17YWAR01	12	DOGWOOD
BURBANK	YWAR	26.5	16.5	FLEDGE	169	18YWAR01	8	DOGWOOD
BURBANK	YWAR	26.5	5.5	FAIL	169	19YWAR01	5	GRAPE
BURBANK	YWAR	26.5	16.5	FLEDGE	169	20YWAR01	8	DOGWOOD
BURBANK	YWAR	26.5	12.5	FLEDGE	169	21YWAR01	6	DOGWOOD
BURBANK	YWAR	26.5	2	FAIL	172	22YWAR01	9	DOGWOOD
BURBANK	YWAR	26.5	9.5	FAIL	172	23YWAR01	4	DOGWOOD
BURBANK	YWAR	26.5	9.5	FAIL	172	24YWAR01	7	DOGWOOD
BURBANK	YWAR	26.5	6	FLEDGE	172	25YWAR01	10	DOGWOOD
BURBANK	YWAR	26.5	5.5	FAIL	176	26YWAR01	6	DOGWOOD
BURBANK	YWAR	26.5	12	UNCERTAIN	176	28YWAR01	10	TTONWOOD
BURBANK	YWAR	26.5	3	FAIL	178	29YWAR01	12	WILLOW
BURBANK	YWAR	26.5	20	FLEDGE	193	30YWAR01	27.5	ASH
CCP	AMRO	32	5	FAIL	150	01AMRO01	30	TTONWOOD

CCP	AMRO	32	18	UNCERTAIN	157	02AMRO01	10	/GRAPE VINE
CCP	AMRO	32	15.5	FAIL	171	03AMRO01	60	TTONWOOD
CCP	AMRO	32	1	UNCERTAIN	171	04AMRO01	15	ELM
CCP	AMRO	32	23	FLEDGE	192	05AMRO01	5	JUNIPER
CCP	AMRO	32	9	FLEDGE	199	06AMRO01	6	DOGWOOD
CCP	BAOR	30.5	37.5	FLEDGE	158	01BAOR01	30	TTONWOOD
CCP	BAOR	30.5	26	FLEDGE	164	02BAOR01	30	TTONWOOD
CCP	BAOR	30.5	12.5	FLEDGE	192	03BAOR01	12	TTONWOOD
CCP	BRTH	28	18.5	FAIL	141	01BRTH01	7	DOGWOOD
CCP	BRTH	28	25.5	FLEDGE	141	02BRTH01	0	JUNIPER
CCP	BRTH	28	8.5	FAIL	171	03BRTH01	5	DOGWOOD
CCP	BRTH	28	8.5	FAIL	147	04BRTH01	0	DOGWOOD
CCP	BRTH	28	6	FAIL	164	05BRTH01	9	ELM
CCP	BRTH	28	16	FAIL	185	06BRTH01	4	DOGWOOD
CCP	BRTH	28	1	UNCERTAIN	177	07BRTH01	6.5	DOGWOOD
CCP	BRTH	28	23	FLEDGE	192	08BRTH01	5	DOGWOOD
CCP	BRTH	28	2	FAIL	150	09BRTH01	3	JUNIPER
CCP	COGR	36	9.5	FAIL	127	01COGR01	18	SSIAN OLIVE
CCP	COGR	36	4.5	FAIL	150	02COGR01	6	DOGWOOD
CCP	EAKI	37.5	35.5	FLEDGE	150	01EAKI01	75	TTONWOOD
CCP	EAKI	37.5	2	FLEDGE	171	02EAKI01	45	TTONWOOD
CCP	EAKI	37.5	33	FLEDGE	157	03EAKI01	40	TTONWOOD
CCP	EAKI	37.5	8	FLEDGE	177	04EAKI01	25	ELM
CCP	EAKI	37.5	12.5	FLEDGE	192	05EAKI01	60	TTONWOOD
CCP	EAWP	31	37	FLEDGE	214	01EAWP01	8	DOGWOOD
CCP	GRCA	27	18	FAIL	144	01GRCA01	7	DOGWOOD
CCP	GRCA	27	5	FLEDGE	185	02GRCA01	5	DOGWOOD
CCP	GRCA	27	16	FLEDGE	185	03GRCA01	7	DOGWOOD
CCP	GRCA	27	10	FLEDGE	206	04GRCA01	7	DOGWOOD
CCP	RBGR	28	1.5	FAIL	150	01RBGR01	9	DOGWOOD
CCP	RBGR	28	10	FAIL	150	02RBGR01	9	ELM
CCP	RBGR	28	5	UNCERTAIN	157	03RBGR01	10	DOGWOOD
CCP	RBGR	28	6	FAIL	157	04RBGR01	12	DOGWOOD
CCP	RBGR	28	9	FLEDGE	171	05RBGR01	7.5	DOGWOOD
CCP	RBGR	28	12	FAIL	177	06RBGR01	8	DOGWOOD
CCP	WAVI	32	6.5	FAIL	141	01WAVI01	50	TTONWOOD
CCP	WAVI	32	27.5	FLEDGE	157	02WAVI01	45	TTONWOOD

CCP	WAVI	32	5	UNCERTAIN	192	03WAVI01	20	TTONWOOD
HIGHLINE	BRTH	28	5	FAIL	143	01BRTH01	3	JUNIPER
HIGHLINE	EAKI	37.5	5.5	FLEDGE	185	01EAKI01	45	TTONWOOD
HIGHLINE	REVI	27.5	19.5	FLEDGE	192	01REVI01	8	BASSWOOD
CCP	GRCA	27	5.5	FAIL	182	02GRCA00	8	DOGWOOD
CCP	GRCA	27	5.5	FLEDGE	182	01GRCA00	6	DOGWOOD
CCP	OROR	28.5	6.5	FAIL	146	01OROR00	7	DOGWOOD
CCP	BRTH	28	17.5	FLEDGE	170	01BRTH00	6	DOGWOOD
CCP	OROR	30.5	1.5	FLEDGE	182	02OROR00	25	ASH
CCP	CEDW	32.5	6.5	FLEDGE	195	01CEDW00	30	TTONWOOD
CCP	EAKI	37.5	2.5	FLEDGE	195	01EAKI00	40	TTONWOOD
		29.4172	2191					

Appendix 3. Raw data for nests in the Big Sioux River corridor located during the study. Codes are the same as in Appendix 1.

SITE	SPECIES	H	EXPOS	RESULT	START DATE	NEST #	HEIGHT	TREE SP.
BSR	AMRO	32	8.5	FL	186	01AMRO00	21	MAPLE
BSR	WOTH	29	12.5	FA	172	01WOTH00	10	HACKBERRY
BSR	BRTH	28	3	FL	187	01BRTH00	10	MULBERRY
UCSP	AMRO	32	5.5	FLEDGE	169	01AMRO01	40	COTTONWOOD
UCSP	BAOR	30.5	12.5	FAIL	155	01BAOR01	25	COTTONWOOD
UCSP	BAOR	30.5	19.5	FLEDGE	169	02BAOR01	35	COTTONWOOD
UCSP	BLGR	25	16.5	FAIL	165	01BLGR01	2	SNOWBERRY
UCSP	BRTH	28	17.5	FLEDGE	143	01BRTH01	2	LILAC
UCSP	BRTH	28	14	FLEDGE	143	02BRTH01	18	PLUM
UCSP	BRTH	28	2.5	FAIL	159	03BRTH01	4	HONEYSUCKLE
UCSP	BRTH	28	12.5	FLEDGE	169	04BRTH01	5.5	PLUM
UCSP	BRTH	28	2.5	FAIL	193	05BRTH01	6	LILAC
UCSP	CEDW	32.5	13	FAIL	179	01CEDW01	4	JUNIPER
UCSP	CHSP	26.5	11.5	FAIL	143	01CHSP01	18	OAK
UCSP	CHSP	26.5	4	FAIL	153	02CHSP01		
UCSP	EAKI	37.5	37	FLEDGE	155	01EAKI01	10	JUNIPER
UCSP	EAKI	37.5	9.5	FAIL	172	02EAKI01	4	ELM
UCSP	EAPH	36	38	FLEDGE	119	01EAPH01	8	PICNIC TABLE
UCSP	EAPH	36	19.5	FLEDGE	176	02EAPH01	8	PICNIC TABLE
UCSP	EAWP	31	19.5	FAIL	169	01EAWP01	60	COTTONWOOD
UCSP	FISP	23.5	9	FAIL	155	01FISP01	0	SHRUB
UCSP	FISP	23.5	26.5	FLEDGE	162	02FISP01	2	SHRUB
UCSP	FISP	23.5	9.5	FAIL	180	03FISP01	1	SHRUB
UCSP	GRCA	27	17.5	FAIL	143	01GRCA01	3	HONEYSUCKLE
UCSP	GRCA	27	9	FAIL	143	02GRCA01	10	SHRUB
UCSP	GRCA	27	11.5	FAIL	148	03GRCA01	4	SHRUB
UCSP	GRCA	27	12.5	FLEDGE	162	04GRCA01	7	PLUM
UCSP	GRCA	27	5.5	FAIL	169	05GRCA01	3	MAPLE
UCSP	GRCA	27	5.5	FAIL	172	06GRCA01	5	HONEYSUCKLE
UCSP	GRCA	27	5.5	FAIL	176	07GRCA01	5.5	SHRUB
UCSP	GRCA	27	19.5	FAIL	169	08GRCA01	10	PLUM
UCSP	GRCA	27	13	FAIL	186	09GRCA01	8	PLUM
UCSP	INBU	25.5	9	FAIL	176	01INBU01	1	GRASS
UCSP	RBGR	28	2	FAIL	162	01RBGR01	6.5	MAPLE
UCSP	RBGR	28	9	FLEDGE	169	02RBGR01	10	ELM

UCSP	RBGR	28	5.5	FLEDGE	183	03RBGR01	17	SUMAC
BSR	AMRE	25	14.5	FAIL	145	01AMRE01	18	BOXELDER
BSR	AMRE	25	16	FAIL	152	02AMRE01	13	MULBERRY
BSR	AMRE	25	23	FLEDGE	165	03AMRE01	12	BOXELDER
BSR	AMRO	32	9.5	FAIL	141	01AMRO01	25	BOXELDER
BSR	AMRO	32	27.5	FLEDGE	146	02AMRO01	18	BOXELDER
BSR	AMRO	32	16.5	FLEDGE	155	03AMRO01	20	MAPLE
BSR	BAOR	30.5	5	FAIL	152	01BAOR01	35	MAPLE
BSR	EAKI	37.5	4.5	CERTAIN	189	01EAKI01	30	BOXELDER
BSR	GRCA	27	15.5	FAIL	144	01GRCA01	13	ASH
BSR	GRCA	27	25.5	FLEDGE	125	02GRCA01	9	BOXELDER
BSR	GRCA	27	16.5	FLEDGE	155	03GRCA01	3.5	BOXELDER
BSR	GRCA	27	3	CERTAIN	165	04GRCA01	21	BOXELDER
BSR	RBGR	28	3.5	FAIL	145	01RBGR01	14	BOXELDER
BSR	RBGR	28	9	FLEDGE	193	02RBGR01	30	MAPLE
BSR	WOTH	29	28.5	FLEDGE	145	01WOTH01	11	ELM
BSR	WOTH	29	20.5	FLEDGE	189	02WOTH01	18	BOXELDER
BSR	YWAR	26.5	11	FAIL	142	01YWAR01	11	MAPLE
BSR	YWAR	26.5	28.5	FLEDGE	142	02YWAR01	45	MAPLE
BSR	YWAR	26.5	21.5	CERTAIN	145	03YWAR01	9	MAPLE
BSR	YWAR	26.5	8.5	FAIL	152	04YWAR01	4	MAPLE
BSR	YWAR	26.5	2	FLEDGE	155	05YWAR01	10	BOXELDER
BSR	YWAR	26.5	3	FAIL	165	06YWAR01	11	BOXELDER
BSR	YWAR	26.5	10	FLEDGE	158	06YWAR01	9	BOXELDER
BSR	YWAR	26.5	2.5	FAIL	158	07YWAR01	10	BOXELDER
BSR	YWAR	26.5	16	FAIL	172	08YWAR01	12	MAPLE
		28.40984	790.5					

Appendix 4. Density (birds/square km) and Relative Abundance (birds/point) for individual species in the summer of 2001. Species Codes are the 4-letter BBL codes.

Woodlots

Species	Density	RA
HOWR	828.9	2.47
AMRO	492.2	1.51
BLJA	172.7	0.80
MODO	129.5	0.73
RHWO	155.4	0.64
EAKI	172.7	0.59
COGR	155.4	0.49
BAOR	155.4	0.47
COYE	43.2	0.46
BCCH	69.1	0.44
HOSP	77.7	0.42
GRCA	112.2	0.41
SOSP	25.9	0.41
RBGR	86.3	0.27
NOFL	51.8	0.27
CHSP	86.3	0.25
EUST	25.9	0.24
INBU	43.2	0.22
AMGO	43.2	0.20
CEDW	43.2	0.19
BHCO	34.5	0.19
BRTH	60.4	0.17
DOWO	51.8	0.15
YBCU	34.5	0.14
RNPH	0.0	0.14
WAVI	51.8	0.12
RWBL	0.0	0.12
FISP	8.6	0.08
AMCR	0.0	0.08
OROR	17.3	0.07
YWAR	25.9	0.05
RHW0	17.3	0.05
EAWP	8.6	0.05
NOCA	8.6	0.03
BBCU	8.6	0.02
HAWO	0.0	0.02
RBWO	0.0	0.02
RWBB	0.0	0.02
VESP	0.0	0.02
WBNU	0.0	0.02
WOTH	0.0	0.02
Grand Total	3298.3	13.05

Missouri River Corridor

Species	Density	RA
HOWR	420.3	1.51
MODO	63.7	0.79
YWAR	299.3	0.76
GRCA	286.6	0.75
WAVI	152.8	0.75
EAKI	146.5	0.75
EAWP	114.6	0.69
BLJA	50.9	0.69
BAOR	197.4	0.66
AMGO	127.4	0.63
BHCO	133.7	0.58
RBGR	152.8	0.54
AMCR	19.1	0.50
BCCH	121.0	0.46
WOTH	31.8	0.44
RHWO	50.9	0.40
NOFL	44.6	0.33
NOCA	38.2	0.33
OROR	101.9	0.29
BEVI	89.1	0.26
EUST	31.8	0.26
CEDW	89.1	0.25
WBNU	50.9	0.25
COGR	31.8	0.25
AMRE	76.4	0.23
AMRO	70.0	0.23
EATO	57.3	0.21
REVI	76.4	0.19
INBU	31.8	0.18
BRTH	38.2	0.16
DOWO	25.5	0.14
YBCU	19.1	0.14
COYE	0.0	0.14
RBWO	31.8	0.10
LEFL	31.8	0.06
HAWO	12.7	0.05
WIFL	6.4	0.05
FISP	0.0	0.05
BBCU	6.4	0.04
GCFL	0.0	0.04
YTVI	6.4	0.03
RWBL	6.4	0.03
SOSP	0.0	0.03
TEWA	6.4	0.01
RTHU	6.4	0.01
ALFL	6.4	0.01
TRFL	0.0	0.01
RNPH	0.0	0.01
EABL	0.0	0.01
Grand Total	3362.2	15.25

Big Sioux River Corridor

Species	Density	RA
HOWR	485.2	1.78
BCCH	188.0	0.83
BLJA	121.3	0.81
RBGR	218.3	0.75
GRCA	188.0	0.72
EATO	66.7	0.59
AMGO	115.2	0.56
FISP	60.6	0.52
EAWP	42.5	0.52
NOCA	48.5	0.47
MODO	24.3	0.47
WBNU	48.5	0.43
AMCR	0.0	0.41
YWAR	127.4	0.33
AMRE	121.3	0.33
INBU	42.5	0.33
AMRO	66.7	0.32
BHCO	36.4	0.32
COYE	24.3	0.32
CEDW	109.2	0.28
WOTH	24.3	0.28
DOWO	54.6	0.23
WITU	0.0	0.19
OVEN	30.3	0.17
RBWO	6.1	0.17
BAOR	42.5	0.16
YBCU	6.1	0.16
BRTH	24.3	0.15
NOFL	24.3	0.14
WAVI	24.3	0.14
EAKI	30.3	0.12
SOSP	24.3	0.07
GCFL	6.1	0.07
RHWO	6.1	0.07
BGGN	30.3	0.06
SCTA	24.3	0.06
CHSP	6.1	0.06
REVI	12.1	0.05
RNPH	0.0	0.05
WODU	0.0	0.05
HAWO	12.1	0.04
COGR	12.1	0.02
RTHU	12.1	0.02
EUST	0.0	0.02
NOBO	0.0	0.02
RTHA	0.0	0.02
EAPH	6.1	0.01
TRFL	6.1	0.01
ALFL	0.0	0.01
BBCU	0.0	0.01
LEFL	0.0	0.01
RWBL	0.0	0.01
YBSA	0.0	0.01
YTVI	0.0	0.01
Grand Total	2565.3	13.84